

Student's Name/Initials

/

Date

Teacher's Initials

Date

**MECHATRONICS INTEGRATED TECHNOLOGIES (MIT) 1, 2, 3, and 4**

**DIRECTIONS:** Evaluate the student using the applicable rating scales below and check the appropriate box to indicate the degree of competency. The ratings 3, 2, 1, and N are not intended to represent the traditional school grading system of A, B, C, and D. The description associated with each of the ratings focuses on the level of student performance or cognition for each of the competencies listed below.

**PERFORMANCE RATING**

- 3 - Skilled--can perform task independently with no supervision  
 2 - Moderately skilled--can perform task completely with limited supervision  
 1 - Limitedly skilled--requires instruction and close supervision  
 N - No exposure--has no experience or knowledge of this task

**COGNITIVE RATING**

- 3 - Knowledgeable--can apply the concept to solve problems  
 2 - Moderately knowledgeable--understands the concept  
 1 - Limited knowledge--requires additional instruction  
 N - No exposure--has not received instruction in this area

**NCCER CONTREN® CORE MODULES****MODULE A. BASIC SAFETY**

3 2 1 N

- \_\_\_ \_\_\_ \_\_\_ 1. Identify the responsibilities and personal characteristics of a professional craftsperson.
- \_\_\_ \_\_\_ \_\_\_ 2. Explain the role that safety plays in the construction crafts.
- \_\_\_ \_\_\_ \_\_\_ 3. Describe what job-site safety means.
- \_\_\_ \_\_\_ \_\_\_ 4. Explain the appropriate safety precautions around common job-site hazards.
- \_\_\_ \_\_\_ \_\_\_ 5. Demonstrate the use and care of appropriate personal protective equipment.
- \_\_\_ \_\_\_ \_\_\_ 6. Follow safe procedures for lifting heavy objects.
- \_\_\_ \_\_\_ \_\_\_ 7. Describe safe behavior on and around ladders and scaffolds.
- \_\_\_ \_\_\_ \_\_\_ 8. Explain the importance of the HazCom (Hazard Communication Standard) requirement and MSDs (Material Safety Data Sheets).
- \_\_\_ \_\_\_ \_\_\_ 9. Describe fire prevention and fire fighting techniques.
- \_\_\_ \_\_\_ \_\_\_ 10. Define safe work procedures around electrical hazards.
- \_\_\_ \_\_\_ \_\_\_ 11. Complete 10-hour OSHA course/assessment and receive card. (SDE Requirement)

**MODULE B. BASIC MATH**

3 2 1 N

- \_\_\_ \_\_\_ \_\_\_ 1. Add, subtract, multiply, and divide whole numbers, with and without a

calculator.

- \_\_\_ \_\_\_ \_\_\_ 2. Use a standard ruler and a metric ruler to measure.
- \_\_\_ \_\_\_ \_\_\_ 3. Add, subtract, multiply, and divide fractions.
- \_\_\_ \_\_\_ \_\_\_ 4. Add, subtract, multiply, and divide decimals, with and without a calculator.
- \_\_\_ \_\_\_ \_\_\_ 5. Convert decimals to percents and percents to decimals.
- \_\_\_ \_\_\_ \_\_\_ 6. Convert fractions to decimals and decimals to fractions.
- \_\_\_ \_\_\_ \_\_\_ 7. Explain what the metric system is and how it is important in the construction trade.
- \_\_\_ \_\_\_ \_\_\_ 8. Recognize and use metric units of length, weight, volume, and temperature.
- \_\_\_ \_\_\_ \_\_\_ 9. Recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them.

**MODULE C: INTRODUCTION TO HAND TOOLS**

3 2 1 N

- \_\_\_ \_\_\_ \_\_\_ 1. Recognize and identify some of the basic hand tools used in the construction trade.
- \_\_\_ \_\_\_ \_\_\_ 2. Use these tools safely.
- \_\_\_ \_\_\_ \_\_\_ 3. Describe the basic procedures for taking care of these tools.

**MODULE D: INTRODUCTION TO POWER TOOLS**

3 2 1 N

- \_\_\_ \_\_\_ \_\_\_ 1. Identify commonly used power tools of the construction trade.
- \_\_\_ \_\_\_ \_\_\_ 2. Use power tools safely.
- \_\_\_ \_\_\_ \_\_\_ 3. Explain how to maintain power tools properly.

**MODULE E: INTRODUCTION TO BLUEPRINTS**

3 2 1 N

- \_\_\_ \_\_\_ \_\_\_ 1. Recognize and identify basic blueprint terms, components, and symbols.
- \_\_\_ \_\_\_ \_\_\_ 2. Relate information on blueprints to actual locations on the print.
- \_\_\_ \_\_\_ \_\_\_ 3. Recognize different classifications of drawings.
- \_\_\_ \_\_\_ \_\_\_ 4. Interpret and use drawing dimensions.

**MODULE F: BASIC RIGGING (Optional)**

3 2 1 N

- \_\_\_ \_\_\_ \_\_\_ 1. Explain how ropes, chains, hoists, loaders, and cranes are used to move material and equipment from one location to another on a job site.
- \_\_\_ \_\_\_ \_\_\_ 2. Describe inspection techniques and load-handling safety practices.
- \_\_\_ \_\_\_ \_\_\_ 3. Explain the American National Standards Institute (ANSI) hand signals.

**MODULE G: BASIC COMMUNICATION SKILLS**  
(SDE Requirement)

3 2 1 N

- |   |   |   |   |    |  |
|---|---|---|---|----|--|
| — | — | — | — | 1. | Explain techniques for communicating effectively with coworkers and supervisors. |
| — | — | — | — | 2. | Demonstrate verbal and written communication skills necessary in the workplace.  |
| — | — | — | — | 3. | Demonstrate telephone and e-communication skills necessary in the workplace.     |

**MODULE H: BASIC EMPLOYABILITY SKILLS**  
(SDE Requirement)

3 2 1 N

- |   |   |   |   |    |  |
|---|---|---|---|----|--|
| — | — | — | — | 1. | Identify the roles of individuals and companies in the construction industry.  |
| — | — | — | — | 2. | Explain the importance critical thinking and problem solving skills in the workplace.  |
| — | — | — | — | 3. | Describe computer systems and their industry applications.   |
| — | — | — | — | 4. | Explain interpersonal relationship skills, self-presentation, and key workplace issues such as sexual harassment, stress, and substance abuse. |

**MECHATRONICS INTEGRATED TECHNOLOGIES (MIT)**  
**1, 2, 3, And 4**

**UNIT A: ELECTRICAL THEORY ONE**

3 2 1 N

- |   |   |   |   |    |   |
|---|---|---|---|----|---|
| — | — | — | — | 1. | Recognize what atoms are and how they are constructed.                                  |
| — | — | — | — | 2. | Define voltage and identify the ways in which it can be produced.                       |
| — | — | — | — | 3. | Explain the difference between conductors and insulators.                               |
| — | — | — | — | 4. | Define the units of measurement that are used to measure the properties of electricity. |
| — | — | — | — | 5. | Explain how voltage, current, and resistance are related to each other.                 |
| — | — | — | — | 6. | Using the formula for Ohm's Law, calculate an unknown value.                            |
| — | — | — | — | 7. | Explain the different types of meters used to measure voltage, current,                 |

and resistance.

- |   |   |   |   |    |   |
|---|---|---|---|----|---|
| — | — | — | — | 8. | Using the power formula, calculate the amount of power used by a circuit. |
|---|---|---|---|----|---|

**UNIT B: ELECTRICAL THEORY TWO**

3 2 1 N

- |   |   |   |   |    |  |
|---|---|---|---|----|--|
| — | — | — | — | 1. | Explain the basic characteristics of a series circuit.   |
| — | — | — | — | 2. | Explain the basic characteristics of a parallel circuit.   |
| — | — | — | — | 3. | Explain the basic characteristics of a series-parallel circuit.  |
| — | — | — | — | 4. | Calculate, using Kirchoff's Voltage Law, the voltage drop in series, parallel, and series-parallel circuits. |
| — | — | — | — | 5. | Calculate, using Kirchoff's Current Law, the total current in parallel and series-parallel circuits.         |
| — | — | — | — | 6. | Find the total amount of resistance in a series circuit.   |
| — | — | — | — | 7. | Find the total amount of resistance in a parallel circuit.   |
| — | — | — | — | 8. | Find the total amount of resistance in a series-parallel circuit.  |

**UNIT C: ELECTRICAL TEST EQUIPMENT**

3 2 1 N

- |   |   |   |   |    |  |
|---|---|---|---|----|--|
| — | — | — | — | 1. | Explain the operation of and describe the following pieces of test equipment:<br>Ammeter<br>Voltmeter<br>Ohmmeter<br>Volt-ohm-milliammeter<br>Wattmeter<br>Megohmmeter<br>Frequency meter<br>Power factor meter<br>Continuity tester<br>Voltage tester<br>Recording instruments<br>Cable-length meters |
| — | — | — | — | 2. | Explain how to read and convert from one scale to another using the above test equipment ( Example: Mhz to KHz).   |
| — | — | — | — | 3. | Explain the importance of proper meter polarity.   |
| — | — | — | — | 4. | Define frequency and explain the use of a frequency meter.   |
| — | — | — | — | 5. | Explain the difference between digital and analog meters.  |

- |   |   |   |   |    |  |
|---|---|---|---|----|--|
| — | — | — | — | 6. | Demonstrate the proper & safe use of electrical test equipment |
|---|---|---|---|----|--|

**UNIT D: INTRODUCTION TO ELECTRICAL BLUEPRINTS**

3 2 1 N

- |   |   |   |   |    |  |
|---|---|---|---|----|--|
| — | — | — | — | 1. | Explain the basic layout of a blueprint.   |
| — | — | — | — | 2. | Describe the information included in the title block of a blueprint.                   |
| — | — | — | — | 3. | Identify the types of lines used on blueprints.  |
| — | — | — | — | 4. | Identify common symbols used on blueprints.  |
| — | — | — | — | 5. | Understand the use of architect's and engineer's scales.                               |
| — | — | — | — | 6. | Interpret electrical drawings, including site plans, floor plans, and detail drawings. |
| — | — | — | — | 7. | Read equipment schedules found on electrical blueprints.                               |
| — | — | — | — | 8. | Describe the type of information included in electrical specifications.                |

**UNIT E: WIRING: COMMERCIAL AND INDUSTRIAL**

3 2 1 N

- |   |   |   |   |     |  |
|---|---|---|---|-----|--|
| — | — | — | — | 1.  | Identify and state the functions and ratings of single-pole, double-pole, three-way, four-way, dimmer, special, and safety switches. |
| — | — | — | — | 2.  | Explain NEMA classifications as they relate to switches and enclosures.  |
| — | — | — | — | 3.  | Explain the NEC requirements concerning wiring devices.  |
| — | — | — | — | 4.  | Identify and state the functions and ratings of straight blade, twist lock, and pin and sleeve receptacles.                          |
| — | — | — | — | 5.  | Identify and define receptacle terminals and disconnects.  |
| — | — | — | — | 6.  | Identify and define ground fault circuit interrupters.   |
| — | — | — | — | 7.  | Explain the box mounting requirements in the NEC.  |
| — | — | — | — | 8.  | Use a wire stripper to strip insulation from a wire.   |
| — | — | — | — | 9.  | Use a solderless connector to splice wires together.   |
| — | — | — | — | 10. | Identify and state the functions of limit switches and relays.   |
| — | — | — | — | 11. | Identify and state the function of switchgear.   |

- — — — 12. Describe the components that make up a cable tray assembly.

**UNIT F: CONDUCTOR TERMINATIONS**

3 2 1 N

- — — — 1. Describe how to make a good conductor termination.
- — — — 2. Prepare cable ends for terminations and splices.
- — — — 3. Install lugs and connectors onto conductors.
- — — — 4. Train cable at termination points.
- — — — 5. Explain the role of the NEC in making cable terminations and splices.
- — — — 6. Explain why mechanical stress should be avoided at cable termination points.
- — — — 7. Describe the importance of using proper bolt torque when bolting lugs onto busbars.
- — — — 8. Describe crimping techniques.
- — — — 9. Select the proper lug or connector for the job.
- — — — 10. Describe splicing techniques.
- — — — 11. Describe the installation rules for parallel conductors.
- — — — 12. Explain how to use hand and power crimping tools.

**UNIT G: CIRCUIT BREAKERS AND FUSERS**

3 2 1 N

- — — — 1. Explain the necessity of overcurrent protection devices in electrical circuits.
- — — — 2. Define the terms associated with fuses and circuit breakers.
- — — — 3. Describe the operation of a circuit breaker.
- — — — 4. Select the most suitable overcurrent device for the application.
- — — — 5. Explain the role of the NEC in specifying overcurrent devices.
- — — — 6. Describe the operation of single-element and time-delay fuses.
- — — — 7. Explain how ground fault circuit interrupters (GFCIs) can save lives.
- — — — 8. Replace a renewable fuse link.
- — — — 9. Calculate short circuit currents.
- — — — 10. Describe troubleshooting and maintenance techniques for overcurrent devices.

**UNIT H: CONTACTORS AND RELAYS**

3 2 1 N

- — — — 1. Describe the operating principles of contactors and relays.
- — — — 2. Select contactors and relays for use in specific electrical systems.
- — — — 3. Explain how mechanical contactors operate.
- — — — 4. Explain how solid-state contactors operate.
- — — — 5. Install contactors and relays according to the NEC requirements.
- — — — 6. Select and install contactors and relays for lighting control.
- — — — 7. Read wiring diagrams involving contactors and relays.
- — — — 8. Describe how overload relays operate.
- — — — 9. Connect a simple control circuit.
- — — — 10. Test control circuits.

**UNIT I: LUBRICATION**

3 2 1 N

- — — — 1. Explain OSHA standards.
- — — — 2. Read and interpret an MSDS.
- — — — 3. Explain the EPA program.
- — — — 4. Explain lubricant storage.
- — — — 5. Explain lubricant classification.
- — — — 6. Explain lubricant film protection.
- — — — 7. Explain properties of lubricants.
- — — — 8. Explain properties of greases.
- — — — 9. Explain how to select lubricants.
- — — — 10. Identify and explain types of additives.
- — — — 11. Identify and explain types of lubricating oils.
- — — — 12. Identify and use lubrication equipment to apply to lubricants.
- — — — 13. Read and interpret a lubrication chart.
- — — — 14. Demonstrate proper installation and maintenance as well as preventive maintenance techniques for industrial machine mechanisms using manufacturer's specifications.

**UNIT J: INTRODUCTION TO BEARINGS**

3 2 1 N

- — — — 1. Identify and explain plain bearings.
- — — — 2. Identify and explain ball bearings.
- — — — 3. Identify and explain roller bearings.

- — — — 4. Identify and explain thrust bearings.
- — — — 5. Identify and explain guide bearings
- — — — 6. Identify and explain flanged bearings.
- — — — 7. Identify and explain pillow block bearings.
- — — — 8. Identify and explain take-up bearings.
- — — — 9. Identify and explain bearing materials.
- — — — 10. Explain bearing designation.

**UNIT K: PRECISION MEASURING TOOLS**

3 2 1 N

- — — — 1. Use levels.
- — — — 2. Use feeler gauges.
- — — — 3. Use calipers.
- — — — 4. Use micrometers.
- — — — 5. Use dial indicators.
- — — — 6. Use protractors.
- — — — 7. Use parallels and gauge blocks.
- — — — 8. Use trammels.
- — — — 9. Use precision straightedges.
- — — — 10. Use speed measurement tools.
- — — — 11. Use pyrometers.

**UNIT L: BASIC MACHINING**

3 2 1 N

- — — — 1. Explain basic safety of machining systems.
- — — — 2. Explain practical applications of machining systems.
- — — — 3. Explain the different types of machining systems ( Lathe, Mill, Drill Press, ETC.)
- — — — 4. Identify the different parts of a machining systems.
- — — — 5. Demonstrate the ability to set up and operate shop machinery: lathe, mill, drill press, and grinder according to handbook.

**UNIT M: BASIC HYDRAULIC SYSTEMS**

3 2 1 N

- — — — 1. Explain hydraulic system safety.
- — — — 2. Explain the principles of hydraulics.
- — — — 3. Identify and explain hydraulic fluids.
- — — — 4. Identify and explain hydraulic system parts.
- — — — 5. Identify and explain hydraulic pumps.

- — — — 6. Identify and explain hydraulic motors.
- — — — 7. Demonstrate the ability to read and interpret fluid power symbols as well as fluid power diagrams.
- — — — 8. Demonstrate correct installation and maintenance as well as preventive maintenance techniques for fluid power systems using service manuals.
- — — — 9. Demonstrate correct troubleshooting and repair methods for fluid power systems using service manuals and gauges.

#### UNIT N: BASIC PNEUMATIC SYSTEMS

- |   |   |   |   |  |
|---|---|---|---|--|
| 3 | 2 | 1 | N |  |
| — | — | — | — | 1. Explain pneumatic safety.                                     |
| — | — | — | — | 2. Explain the physical characteristics of gases.                |
| — | — | — | — | 3. Explain compressing gases.                                    |
| — | — | — | — | 4. Explain the pneumatic transmission of energy.                 |
| — | — | — | — | 5. Explain the principles of compressor operation.               |
| — | — | — | — | 6. Identify and explain types of compressors.                    |
| — | — | — | — | 7. Explain compressed-air treatment.                             |
| — | — | — | — | 8. Identify and explain pneumatic system components and symbols. |

#### UNIT O: MOTOR MAINTENANCE, PART ONE

- |   |   |   |   |  |
|---|---|---|---|--|
| 3 | 2 | 1 | N |  |
| — | — | — | — | 1. Properly store motors and generators.   |
| — | — | — | — | 2. Test motors and generators.   |
| — | — | — | — | 3. Make connections for specific types of motors and generators.   |
| — | — | — | — | 4. Clean open-frame motors.  |
| — | — | — | — | 5. Lubricate motors that require this type of maintenance.   |
| — | — | — | — | 6. Collect and record motor data.  |
| — | — | — | — | 7. Select tools for motor maintenance.   |
| — | — | — | — | 8. Select instruments for motor testing.   |
| — | — | — | — | 9. Demonstrate troubleshooting and repair methods for industrial machine mechanisms per manufacturer's specifications. |

#### UNIT P: PROGRAMMABLE LOGIC CONTROLLERS

- |   |   |   |   |  |
|---|---|---|---|--|
| 3 | 2 | 1 | N |  |
| — | — | — | — | 1. Describe the function and purpose of a programmable logic controller (PLC).                 |
| — | — | — | — | 2. Compare hardwired and PLC systems.  |
| — | — | — | — | 3. Count and convert between number systems.   |
| — | — | — | — | 4. Explain the purpose of binary codes.  |
| — | — | — | — | 5. Describe the purpose of the various power supplies used within a PLC.                       |
| — | — | — | — | 6. Explain the general function of input/output (I/O) modules.                                 |
| — | — | — | — | 7. Explain the power supply and ground connections to I/O modules.                             |
| — | — | — | — | 8. State the function of the PLC processor module.   |
| — | — | — | — | 9. Explain the interrelations between microprocessor components.                               |
| — | — | — | — | 10. State the characteristics of the different types of memory.                                |
| — | — | — | — | 11. Describe the characteristics and features of a PLC processor module.                       |
| — | — | — | — | 12. Explain the purpose of PLC software and firmware.  |
| — | — | — | — | 13. Describe the features and the differences between the different PLC programming languages. |
| — | — | — | — | 14. Describe the features of relay ladder logic instruction categories.                        |
| — | — | — | — | 15. Explain the principles used to correlate PLC hardware components to software instructions. |
| — | — | — | — | 16. Convert a hardware ladder diagram to a PLC ladder diagram.                                 |
| — | — | — | — | 17. Program PLC using above diagram.   |
| — | — | — | — | 18. Troubleshoot problems in PLC circuit using a given diagram.                                |

#### UNIT Q: ROBOTICS SYSTEMS

- |   |   |   |   |  |
|---|---|---|---|--|
| 3 | 2 | 1 | N |  |
| — | — | — | — | 1. Explain basic safety of robotics systems.           |
| — | — | — | — | 2. Explain OSHA requirements for robotics systems.     |
| — | — | — | — | 3. Explain practical applications of robotics systems. |
| — | — | — | — | 4. Explain the different types of robots.              |

- — — — 5. Identify the different parts of a robot.
- — — — 6. Demonstrate the ability to service, maintain, and troubleshoot a simple robot.

#### MECHATRONICS INTEGRATED TECHNOLOGIES (MIT) – ADVANCED

For schools with more classroom instructional hours, choose from the list of advanced standards for your second and third year students. The first priority in adding standards would be to include industrial motor controls to your customized list.

#### ADVANCED UNIT A: FASTENERS AND ANCHORS

- |   |   |   |   |  |
|---|---|---|---|--|
| 3 | 2 | 1 | N |  |
| — | — | — | — | 1. Identify and explain the use of threaded fasteners.             |
| — | — | — | — | 2. Identify and explain the use of non-threaded fasteners.         |
| — | — | — | — | 3. Identify and explain the use of anchors.                        |
| — | — | — | — | 4. Demonstrate the correct applications for fasteners and anchors. |
| — | — | — | — | 5. Install fasteners and anchors.                                  |

#### ADVANCED UNIT B: INTRODUCTION TO THE NEC

- |   |   |   |   |   |
|---|---|---|---|---|
| 3 | 2 | 1 | N |   |
| — | — | — | — | 1. Explain the purpose and history of the National Electrical Code (NEC).   |
| — | — | — | — | 2. Describe the layout of the NEC.  |
| — | — | — | — | 3. Explain how to navigate the NEC.   |
| — | — | — | — | 4. Describe the purpose of the National Electrical Manufacturers' Association (NEMA) and the National Fire Protection Association (NFPA). |
| — | — | — | — | 5. Explain the role of testing laboratories.  |

#### ADVANCED UNIT C: ALTERNATING CURRENT

- |   |   |   |   |   |
|---|---|---|---|---|
| 3 | 2 | 1 | N |   |
| — | — | — | — | 1. Calculate the peak and effective voltage or current values for an AC waveform. |
| — | — | — | — | 2. Calculate the phase relationship between two AC waveforms.                     |
| — | — | — | — | 3. Describe the voltage and current phase relationship in a resistive AC circuit. |

- — — — 4. Describe the voltage and current transients that occur in an inductive circuit.
- — — — 5. Define inductive reactance and \ state how it is affected by frequency.
- — — — 6. Describe the voltage and current transients that occur in a capacitive circuit.
- — — — 7. Define capacitive reactance and state how it is affected by frequency.
- — — — 8. Explain the relationship between voltage and current in the following types of AC circuits:
  - RL circuit
  - LC circuit
- — — — 9. Describe the effect that resonant frequency has on impedance and current flow in a series or parallel resonant circuit.
- — — — 10. Define bandwidth and describe how it is affected by resistance in a series or parallel resonant circuit.
- — — — 11. Explain the following terms as they relate to AC circuits:
  - True power
  - Reactive power
  - Apparent power
  - Power factor
- — — — 12. Explain basic transformer action.

#### ADVANCED UNIT D: MOTORS: THEORY AND APPLICATION

3 2 1 N

- — — — 1. Define the following terms:
  - Ampacity
  - Branch circuit
  - Circuit breaker
  - Controller
  - Duty
  - Equipment
  - Full-load amps
  - Ground fault circuit interrupter
  - Interrupting rating
  - Motor circuit switch
  - Thermal protector
  - NEMA design letter
  - Nonautomatic
  - Overcurrent
  - Overload
  - Power factor
  - Rated full-load speed

- — — — -Rated horsepower
- — — — -Service factor
- — — — -Thermal cutout
- — — — -Remote control circuit
- — — — 2. Describe the various types of motor enclosures.
- — — — 3. Describe how the rated voltage of a motor differs from the system voltage.
- — — — 4. Describe the basic construction and components of a three-phase squirrel cage induction motor.
- — — — 5. Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor.
- — — — 6. Describe how torque is developed in an induction motor.
- — — — 7. Explain how and why torque varies with rotor reactance and slip.
- — — — 8. Define percent slip and speed regulation.
- — — — 9. Explain how the direction of a three-phase motor is reversed.
- — — — 10. Describe the component parts and operating characteristics of a three-phase wound rotor induction motor.
- — — — 11. Describe the component parts and operating characteristics of a three-phase synchronous motor.
- — — — 12. Define torque, starting current, and armature reaction as they apply to DC motors.
- — — — 13. Explain how the direction of rotation of a DC motor is changed.
- — — — 14. Describe the design and characteristics of a DC shunt, series, and compound motor.
- — — — 15. Describe dual-voltage motors and their applications.
- — — — 16. Describe the methods for determining various motor connections.
- — — — 17. Describe general motor protection requirements as delineated in the NEC.

#### ADVANCED UNIT E: CONDUCTORS

3 2 1 N

- — — — 1. Explain the various sizes and gauges of wire in accordance with American Wire Gauge standards.
- — — — 2. Identify insulation and jacket types according to conditions and

- — — — applications.
- — — — 3. Describe voltage ratings of conductors and cables.
- — — — 4. Read and identify markings on conductors and cables.
- — — — 5. Use the tables in the NEC to determine the ampacity of a conductor.
- — — — 6. State the purpose of stranded wire.
- — — — 7. State the purpose of compressed conductors.
- — — — 8. Describe the different materials from which conductors are made.
- — — — 9. Describe the different types of conductor insulation.
- — — — 10. Describe the color coding of insulation.
- — — — 11. Describe the instrumentation control wiring.
- — — — 12. Describe the equipment required for pulling wire through conduit.
- — — — 13. Describe the procedure for pulling wire through conduit.
- — — — 14. Install conductors in conduit.
- — — — 15. Pull conductors in a conduit system.

#### ADVANCED UNIT F: OXYFUEL CUTTING

3 2 1 N

- — — — 1. Explain oxyfuel cutting safety.
- — — — 2. Identify and explain oxyfuel cutting equipment.
- — — — 3. Set up oxyfuel equipment.
- — — — 4. Light and adjust an oxyfuel torch.
- — — — 5. Shut down oxyfuel cutting equipment.
- — — — 6. Disassemble oxyfuel equipment.
- — — — 7. Change empty cylinders.
- — — — 8. Perform oxyfuel cutting:
  - Straight line and square shapes
  - Piercing and slot cutting

#### ADVANCED UNIT G: CABLE TRAY

3 2 1 N

- — — — 1. Describe the components that make up a cable tray assembly.
- — — — 2. Explain the methods used to hang and secure cable tray.
- — — — 3. Describe how cable enters and exits cable tray.
- — — — 4. Select the proper cable tray fitting for the situation.
- — — — 5. Explain the NEMA standards for cable tray installations.

- |   |   |   |   |     |  |
|---|---|---|---|-----|--|
| — | — | — | — | 6.  | Explain the NEC requirements for cable tray installations.                                   |
| — | — | — | — | 7.  | Select the required fittings to ensure equipment grounding continuity in cable tray systems. |
| — | — | — | — | 8.  | Interpret electrical working drawings showing cable tray fittings.                           |
| — | — | — | — | 9.  | Size cable tray for the number and type of conductors contained in the system.               |
| — | — | — | — | 10. | Select rollers and sheaves for pulling cable in specific cable tray situations.              |
| — | — | — | — | 11. | Designate the required locations of rollers and sheaves for a specific cable pull.           |
| — | — | — | — | 12. | Fabricate an offset for a cable tray.  |

#### **ADVANCED UNIT H: SMAW EQUIPMENT AND SETUP**

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| 3 | 2 | 1 | N |   |
| — | — | — | — | 1. Identify and explain SMAW safety.                |
| — | — | — | — | 2. Identify and explain welding electrical current. |
| — | — | — | — | 3. Identify and explain arc welding machines.       |
| — | — | — | — | 4. Explain setting up arc welding equipment.        |
| — | — | — | — | 5. Identify and explain tools for weld cleaning.    |